Distance to Asteroid 1998wt

Introduction: On March 4, 2005, telescopes from two different observatories in the United States took simultaneous images of an asteroid called "1998wt". The two observatories were Gettysburg College Observatory in Pennsylvania and Yerkes Observatory (24" telescope) in southern Wisconsin. They are approximately 970 km apart as the crow flies. This was not a new discovery of an asteroid, but the images were taken to demonstrate the use of parallax to determine the distance to a relatively nearby object in the sky. When you view these images you will discover a noticeable difference in the location of the asteroid against the background stars as you compare one set of images to the other set. A measurement of this "parallax shift" and the knowledge of the distance between the telescopes will allow you to calculate the distance to "1998wt".

Images: 6 available in the folder "KPNO Images" within the desktop folder, "HOU Extra Images". They are labeled as follows: 1998wt-050304-0245g, 1998wt-050304-0250g, 1998wt-050304-0255g, 1998wt-050304-0245y, 1998wt-050304-0250y, 1998wt-050304-0255y. (Don't use those labeled "zoom".) The three images ending in "g" are from the Gettysburg scope. Those ending in "y" are from the Yerkes scope. The "050304" indicates the date, March 4, 2005. The "0245", etc. indicates the time the images were taken in Universal Time (UT). As you can see the images were taken simultaneously and with 5 minute intervals.

Procedure:

1. Using the HOU-IP software open the three Yerkes images. The Yerkes images have a smaller field of view, so it's a bit easier to analyze these images. If you choose, try to locate the asteroid moving through this field by comparing the 0245 and 0250 images. Often an asteroid will have something of an elongated, sausage-like look. Once you have found the asteroid then see if you can find it in the 0255 image. If you're unsuccessful, or as a confirmation, use the procedure in step #2 below to locate the asteroid.

2. Use the "subtract" tool in the software to subtract 0250y from 0245y. Make sure you "Display result in a new window". Now you should be able to locate the asteroid's tell-tale trace with the white and black spots. Go back to the two original images to see if you can now see the asteroid. You will want to do that with image 0255y as well.

3. At this point it's a good idea to identify the x-y coordinates of the asteroid in the three images so you can locate it later in your procedure. The HOU software has a tool, **Auto Aperture**, which will help you do this. You can find this tool under the Data Tools menu, or locate the icon in the tool bar that looks like a small target. Just click on that button. Bring the cursor down onto one of the images and click on the asteroid. You will see a "Results" window open up that gives you 3 lines of information, including the coordinates of the asteroid. Those coordinates are in (x,y) format and in units of pixels. Record that information.

4. For the moment minimize the three Yerkes images. Open the three Gettysburg images, and go through the same analysis as you have done with the Yerkes images. You

will notice the obvious difference that these images have a much larger field of view, so finding the asteroid by sight is quite difficult. You might bring up one of the Yerkes images to compare. Keep in mind, these telescopes were looking at the same star fields at the same time. You will also notice that the "stars" in the Yerkes images are farther apart, indicating a different Plate Scale.

5. At this point you may have decided to use "subtraction" with these images as well. In any case, use the Auto Aperture tool to measure the coordinates of the asteroid in the three Gettysburg images. Record that information.

6. Now you're at the point of measuring the parallax shift of the asteroid. If the two telescopes were identical and using the same cameras, then this process would be very simple. You would subtract one of the "g" images from one of the "y" images. Then you would measure the pixel shift and convert the pixels to an angle using the Plate Scale. It's not possible here since the plate scales and image sizes are different. So another procedure is called for. The following is a broad outline.

7. Using the HOU software open one image from each telescope. The two images must be of the same time (0245, 0250 or 0255). Shrink down the window of the "g" image so that you can place the two images, side by side, on the screen. Identify the asteroid in each image by using the Auto Aperture tool.

8. You now need to do a determination of how far the asteroid has shifted from one image to another, due to the two positions of the observatories. This is where you'll need to use your creativity. You have all the raw data you need in the images, along with the plate scales for each (given below). You'll undoubtedly want to make some approximations and/or some assumptions which may introduce some error. If you have time you can try several, perhaps more accurate, approaches. But take one approach all the way so you can calculate the distance to 1998wt.

You'll probably need to use a reference star, common to both images, that's reasonably close to the asteroid….but not necessarily. Initially you'll measure in pixels and, later, convert those pixels to an angle in arcsecs. Keep in mind that, because of the different plate scales, the pixel measurements between any two, **fixed stars** will be different, but the angular spacing will be the same. You might want to check that by using the plate scales below.

Plate Scales: Yerkes = 0.62 "/px.; Gettysburg = 1.09 "/px.

9. Now that you have the parallax shift in arcsecs, use the equation for parallax and calculate the distance to 1998wt. The baseline between the telescopes is ~970 km.

10. Convert the distance above to AU's. What do you notice about this number? Does it seem reasonable or surprise you? You might check on the following website for more information about this asteroid and further information on parallax: http://spiff.rit.edu/richmond/parallax/1998wt/par_1998wt.html.